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WORKING MEMORY IN SCIENCE STUDENTS IS BETTER THAN IN SOCIAL STUDIES STUDENTS WITH THE SAME LEARNING STYLE

Memori Kerja pada Siswa IPA Lebih Baik daripada Siswa IPS dengan Gaya Belajar yang Sama

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ABSTRAK

Memori kerja adalah sistem yang bekerja dalam menyimpan dan memanipulasi/pengolahan informasi. Mekanisme memori kerja ada empat model, yaitu phonological loop, visuospasial sketchpad, central executive, dan episodic buffer. Ada berbagai macam faktor yang memengaruhi kinerja memori kerja, seperti umur, gangguan mental, specific learning disorder, dan edukasi. Pola pikir terbentuk dari memori yang tersimpan dimasing-masing individu. Untuk memahami pelajaran yang didapatkan, murid menghasilkan model gaya belajar yang berbeda terdiri atas empat kelompok, yaitu converger, assimilator, divergen, dan accomodator. Peneliti tertarik untuk meneliti perbedaan memori kerja antara jurusan IPA (Ilmu Pengetahuan Alam) dengan IPS (Ilmu Pengetahuan Sosial) dan gaya belajar yang ada di jurusan IPA dan IPS siswa kelas XII SMA Negeri 15 Tangerang. Desain penelitian yang digunakan ialah studi perbandingan atau comparative study, dengan pendekatan cross sectional. Teknik sampling yang digunakan adalah teknik purposive sampling, dengan jumlah sampel 144 siswa. Statistik yang digunakan adalah uji analisis bivariat non parametrik. Penelitian mengunakan alat Digit Span Test dan kuesioner gaya belajar David Kolb. Hasil penelitian didapatkan adanya perbedaan kapasitas memori kerja antara jurusan IPA (mean:81,47) dengan jurusan IPS (mean:63,26) untuk hasil digit span test. Gaya belajar yang dimiliki siswa kelas XII jurusan IPA dengan jurusan IPS SMA Negeri 15 Tangerang didapatkan sama, yaitu akomodator dan konverger. Hal ini dapat terjadi karena faktor dari dalam (psikologi dan fisiologi siswa) dan faktor dari luar (lingkungan belajar, intrumen/alat pendukung proses belajar, dan materi pelajaran).

***Kata kunci**: digit span test, gaya belajar, memori kerja, siswa SMA*

ABSTRACT

Working memory is a system that operates in storing and processing information. There are four models of working memory mechanisms, namely the phonological loop, visuospatial sketchpad, central executive, and episodic buffer. Various factors influence working memory performance, such as age, mental disorders, specific learning disorders, and education. Mindset is formed from the stored memories of each individual. To understand the lessons learned, students produce different learning style models consisting of four groups: convergers, assimilators, divergers, and accommodators. Researchers are interested in investigating the differences in working memory between natural science (IPA) and social science (IPS) majors and the learning styles present in the natural science and social science departments of 12th-grade students at SMA Negeri 15 Tangerang. The research design used is a comparative study, with a cross-

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sectional approach. The sampling technique used is purposive sampling, with a sample size of 144 students. The statistics used are bivariate non parametric analysis test. The research uses the Digit Span Test tool and David Kolb's learning style questionnaire. The research results indicate differences in working memory capacity between natural science majors (mean: 81,47) and social science majors (mean: 63,26), The learning styles possessed by 12th-grade students majoring in natural science and social science at SMA Negeri 15 Tangerang are found to be the same, namely accommodator and converger. This can occur due to factors from within (psychological and physiological factors of students) and factors from outside (learning environment, learning instruments/tools, and course materials)

Keywords: digit span test, learning style, SMA student, working memory

INTRODUCTION

Working memory is a cognitive control system that is useful for maintaining and manipulating information in the face of interference. This memory works by actively maintaining the latest information over a certain period of time, so that it can be accessed during learning, reasoning, planning, and problem solving. The working memory model has four components: the phonological loop for processing verbal information, the visuospatial sketchpad for visually obtained information, the central executive as the part that collects the information obtained and focuses attention, and the episodic buffer tasked with integrating information obtained from various sources, then binding various pieces of information into a coherent memory.[1], [2].

Working memory helps fill acquired information into short-term memory, acting as a storage area, using various memory retention strategies. There are five strategies for storing and retaining information: repetition, chunking, elaboration, visual imagery, and attentional focus. Repetition involves repeating information to oneself to keep it active in memory. Then there's chunking, which uses a method of grouping pieces of information into larger, more meaningful units. Next, there's elaboration, which involves connecting new information with existing knowledge or experience. Visual imagery, which creates a mental picture of information, can also be an effective strategy for maintaining working memory. Finally, attentional focus involves paying attention to information when it's first presented.[3],[4].

Various factors can affect working memory performance, such as age, mental health problems, specific learning disorders (SLD), and education. Research by Ebaid and Crewther (2018) found that working memory performance declines begin to appear in individuals over 65. Chronic stress can lead to working memory impairment, possibly due to changes in the brain's prefrontal cortex, which is responsible for working memory processes.[5], [6].

SLDs such as dyslexia, dyscalculia, etc. can be factors that cause someone to be weak in processing working memory. Finally, research conducted by Choi, Lee, and Seo (2014) found that educational level had a significant influence on working memory ability, reaching 29.8% because education influences a person's cognitive development.[7],[8].Cognitive processes refer to the mental activities that occur in the brain as a person processes information. These processes include perception, attention, memory, language, thinking, problem-solving, and decision-making. Among high school students, there are differences between the Natural Sciences (IPA) and Social Sciences (IPS) majors. These two majors receive different academic methods, resulting in different ways of thinking and resulting in different learning styles. David Kolb's theory classifies student learning styles into four types: diverger, assimilator, converger, and accommodator. A study conducted by Awru (2020) found differences in learning styles between students majoring in Natural Sciences and Social Sciences. Science students

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tend to use converger and assimilator learning styles, while Social Sciences students tend to use diverger and accommodator learning styles.[9],[10].

Based on these differences in learning styles, the researcher was interested in examining whether learning styles are related to working memory ability and also comparing the working memory abilities of 12th-grade science students with those majoring in social studies at SMA Negeri 15 Tangerang. Furthermore, the researcher wanted to understand the working memory abilities of the two majors at SMA Negeri 15 Tangerang.

METHODS

The type of research conducted was a comparative study, with a cross-sectional approach.The research was carried out on the same date and time for each class, namely December 13, 2023, and was carried out in the XII IPA and IPS classrooms of SMA Negeri 15 Tangerang.The sampling technique used was purposive sampling, which involves taking all samples that meet the researcher's criteria and needs. This technique was chosen so that the researcher could exclude samples affected by factors that influence working memory storage performance.[11]. Before the research was conducted, the researcher had received an ethical review pass letter (SLKE) with the number: 08/SKKE-IM/UKKW/FKIK/KE/X/2013 from the Medical and Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Krida Wacana Christian University (Ukrida) Jakarta.

The inclusion criteria in this study are students of SMA Negeri 15 Tangerang in the 2022/2023 academic year who are willing to be respondents and have agreed to the informed consent form, students who are willing to first fill out a Googleform questionnaire from the researcher, are 16 years or older, and can understand and use Indonesian. Meanwhile, exclusion criteria include students with a history of severe head trauma or a history of other neurological diseases, have SLD limitations such as dyslexia, have a history of mental illness, such as depression, anxiety, etc., and students who did not complete the DST.In this study, the number of samples was 148 students, however, 144 students met the inclusion criteria, with details of 72 science class students and 72 social studies class students, while four students were excluded.

The instrument used was a learning style questionnaire, which was validated in Lukito's (2022) study. Furthermore, to measure working memory, the Digit Span Test (DST) was used, consisting of Forward Digit Span (FSD) and Backward Digit Span (BDS).This test was used in Winoto's (2017) research and was sourced from the WAIS (Wechsler Adult Intelligence Scale) psychological test tool.[12],[13].

The DST used in this study measures the central executive working memory mechanism and the episodic buffer of verbal information processing (phonological loop). Researchers chose the DST because it has been proven valid for measuring an individual's working memory capacity. This tool measures how much information an individual receives can be retained and processed/manipulated by working memory, which includes the central executive and episodic buffers, which are the main points of the test measuring working memory.[14],[15].

The DST consists of eight items on the Digit Span Forward (DSF) and seven items on the Digit Span Backward (DSB). In the DSF, the number sequence ranges from two to eight digits, while in the DSB, it ranges from two to seven digits. If the respondent gives an incorrect answer, the item is repeated once. If errors persist, the measurement is stopped. Each correct answer is scored 1, and each incorrect answer is scored 0. The overall score range is 0–15. In research conducted by Bloemen (2020), the DST score range for assessing working memory is a range of 1-4 is considered very poor, a range of 5-7 is considered poor, a range of 8-12 is considered average, a range of 13-15 is considered good, and a range of 16-17 is considered very good.[16]. Data processing was carried out by comparing the results of the digit span test between the science

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department and the social science department using the SPSS 24 program, non-parametric bivariate analysis.

RESULT

Table 1. Frequency Distribution of Learning Styles in Science (IPA) and Social Studies (IPS) Majors, Grade XII, SMA Negeri 15 Tangerang

Major	Learning Style	n	%	Valid Percent	Cumulative Percent
Science (IPA)	Assimilator	11	15,3	15,3	15,3
	Converger	21	29,2	29,2	44,4
	Accomodator	40	55,6	55,6	100,0
	Total	72	100,0	100,0	
Social Studies (IPS)	Assimilator	14	19,4	19,4	19,4
	Converger	17	23,6	23,6	43,1
	Accomodator	41	56,9	56,9	100,0
	Total	72	100,0	100,0	

Based on Table 1, in the Science (IPA) class, the most common learning style was accommodator (55.6%), followed by converger (29.2%), and assimilator (15.3%). Meanwhile, in the Social Studies (IPS) class, the results showed that the predominant learning style was also accommodator (56.9%), followed by converger (23.6%) and assimilator (19.4%).

Table 2. Frequency Distribution of Digit Span Test Results in Science and Social Studies Majors, Grade XII, SMA Negeri 15 Tangerang

		n	%	Valid Percent	Cumulative Percent
Science (IPA)	Poor	7	9,7	9,7	9,7
	Average	57	79,2	79,2	88,9
	Good	8	11,1	11,1	100,0
	Total	72	100,0	100,0	
Social Studies (IPS)	Poor	11	15,3	15,3	15,3
	Average	59	81,9	81,9	97,2
	Good	2	2,8	2,8	100,0
	Total	72	100,0	100,0	

Based on Table 2, the digit span test results in the Science major showed that 79.2% of students scored in the average category, 11.1% in the good category, and 9.7% in the poor category. Meanwhile, in the Social Studies major, 81.9% of students scored in the average category, 2.8% in the good category, and 15.3% in the poor category. To determine whether the data were normally distributed, a Kolmogorov–Smirnov normality test was conducted. The test results showed a significance value of Sig. (2-tailed) = 0.01, which is less than 0.05. This indicates that the data in this study were not normally distributed

Table 3. Mann–Whitney Test Results of Digit Span Test between Science and Social Studies Majors, Grade XII, SMA Negeri 15 Tangerang

	Major	N	Mean Rank	Sum of Ranks	p-value
skordigitspan	Science	72	81,74	5885,00	
	Social Studies	72	63,26	4555,00	0,007
	Total	144			

Since the normality test results showed that the data were not normally distributed, the comparison of digit span test scores between Science and Social Studies majors was analyzed using the non-parametric Mann–Whitney test. Based on Table 3, the mean rank of the digit span test scores for Science students was 81.74, while that for Social Studies students was 63.26. The Mann–Whitney statistical test yielded a significance value of Sig. (2-tailed) = 0.007, which is less than 0.05. This indicates that there is a

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statistically significant difference in working memory capacity between science and social studies majors.

DISCUSSION

Based on Table 1, in the Science (IPA) class, the most common learning style was accommodator (55.6%), followed by converger (29.2%). Although in smaller proportion, there were also students with the assimilator learning style (15.3%). In the Social Studies (IPS) class, the distribution of learning styles showed a similar pattern to the Science class, but with slightly different proportions: accommodator (56.9%), converger (23.6%), and assimilator (19.4%).

The similarity in learning styles between Science and Social Studies students at SMA Negeri 15 Tangerang may reflect recent changes in teaching techniques, which increasingly emphasize problem-based learning, innovation, and students' readiness to apply their knowledge. These approaches tend to foster accommodator and converger learning styles. Furthermore, the widespread use of social media and the availability of digital content have influenced students' study habits, enabling them to solve problems more quickly compared to focusing on theoretical understanding, analysis, and objective reasoning. This shift not only enhances critical thinking but also supports the development of skills and creativity—characteristics often associated with the assimilator learning style[17].

This finding differs from the study conducted by Awru (2020), which reported that students in the Science major tended to have converger and assimilator learning styles, whereas students in the Social Studies major were more likely to adopt diverger and accommodator learning styles. Such differences may occur because each student's learning style can vary depending on the course of their individual learning process. This process is influenced by both internal and external factors. Internal factors include students' psychological and physiological conditions, while external factors consist of the learning environment, instruments or tools that support the learning process, and the learning materials provided [9], [12].

In addition, Fuad (2015) explained that each learning style is associated with specific learning methods that focus on the aspects students pay attention to. For example, students with a diverger style emphasize feelings and observations, often using group discussion methods. Meanwhile, students with an assimilator style combine thinking and observing, which aligns more with written reflection assignments[18],[19]. The similarity in learning styles between Science and Social Studies students at SMA Negeri 15 Tangerang may also be explained by the possibility that students themselves do not fully understand which learning style suits them best and may only recognize or apply a single style of learning.

Based on Table 2, the digit span test results in the Science major showed that 79.2% of students scored in the average category, 11.1% in the good category, and 9.7% in the poor category. In the Social Studies major, 81.9% of students scored in the average category, 15.3% in the poor category, and only 2.8% in the good category. Findings from Setyo (2015) indicate that at the age of 16, the prevalence of low working memory capacity is lower compared to the ages of 6 to 12 years. At this developmental stage, working memory functions have reached maturity, as reflected in improved accuracy and processing speed, the ability to multitask, solve more complex problems, process information automatically without explicit strategy formation, and enhanced capacity for planning and strategic thinking[20].

Based on Table 3, the mean rank of digit span test scores was 81.74 for Science students and 63.26 for Social Studies students. The statistical test showed a significance value of $p = 0.007$, indicating that there was a significant difference in working memory capacity between Science and Social Studies majors.The assessment of working memory capacity using the digit span test suggests that students in the Science class

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performed better than those in the Social Studies class. However, this result should not be considered an absolute measure, as the digit span test primarily emphasizes short-term memory capacity in recalling sequences of numbers—an ability that may be more easily performed by Science students (with an analytical/exact orientation). Alternative methods for assessing working memory capacity, such as the semantic span test, place greater emphasis on understanding meaning and forming associations between words, which may be more suitable for Social Studies students (with a social orientation)[3].

Different academic methods emphasize different skills and ways of thinking, which can influence how students develop their cognitive processes. Consequently, Science (IPA) and Social Studies (IPS) classes exhibit differences in thinking patterns. Science classes tend to develop skills in logical reasoning and quantitative analysis, whereas Social Studies classes more often foster skills in critical thinking and qualitative analysis. However, individual differences in cognitive abilities, experiences, and learning strategies also play a role in shaping how these cognitive processes are developed and applied, ultimately affecting working memory [9].

In Blasiman's (2018) study, factors influencing working memory were divided into two categories: chronic factors and acute factors. Chronic factors include intelligence and personality, as these traits remain relatively stable over time. Acute factors, on the other hand, include dieting (not in terms of weight loss or calorie restriction, nor eating patterns per se, but rather the distracting thoughts about food and body image). Such intrusive thoughts reduce the cognitive resources available for tasks that rely on working memory, since dieting requires self-monitoring and attention to maintain dietary behaviors. Other acute factors include meditation, mindfulness, physical exercise, and the use of medication, all of which may affect working memory, although the duration of their effects remains uncertain[14].

Furthermore, the study also explained that there are many variations of tests used to measure working memory, each assessing different stimuli, which presents a challenge in interpreting or comparing the results of working memory studies. The digit span test employed in this research measures the central executive and episodic buffer mechanisms of verbal information processing (phonological loop). In contrast, the visuospatial sketchpad is typically measured using the Operation Span (O-Span) test, which involves a series of simple mathematical and arithmetic tasks. Moreover, the strategies individuals use to retain newly acquired information can also influence working memory. According to Norris (2021), the most effective memory storage strategy is chunking [14], [21].

The strength of this study lies in its ability to identify differences in working memory capacity between Science and Social Studies majors, while also describing the predominant learning styles in each major. These findings may serve as a reference for further studies conducted in school settings. However, this study has limitations. It examined only a single variable, whereas working memory can be influenced by many other factors, including neurological health, mental health, learning ability, and learning style.

CONCLUSION

The results of this study show that the digit span test scores of Grade XII students in both Science and Social Studies majors at SMA Negeri 15 Tangerang were largely within the average category (Digit Span Test scale 8–12). This category reflects that students' working memory capacity is at a general level compared to their peers and is sufficient to perform everyday cognitive tasks. The findings also revealed a significant difference in working memory capacity between Science and Social Studies students ($p = 0.007$).

The predominant learning styles among Grade XII students in both majors were accommodator and converger. Future research is recommended to examine and identify other factors influencing working memory, since these are not only internal (individual-

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related) but also external (environmental). Researchers are also encouraged to consider different working memory assessment tools depending on the focus of the study. For instance, if the aim is to assess students' language and linguistic ability, the reading span test may be more appropriate, whereas if the goal is to measure visuospatial sketchpad mechanisms, the O-span test would be more suitable.

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